physical geography of the country. There were doubts also as to the objects from the occurrence of which the presence of man was inferred, for, except in some very doubtful instances, it was not his bones that were found, but only flints roughly fashioned into serviceable instruments. A good sketch of the development of the inquiry appeared some years ago in *Blackwood's Magazine* (vol. clvii., June 1895, p. 939).

M. Boucher de Perthes had conceived the idea that so it must be, but it was long before he found sufficiently convincing evidence of the fact. At last, however, after Boucher de Perthes had been excavating, collecting, talking, and writing about it for years, Dr. Falconer visited him and acknowledged that a good *primâ facie* case had been made out, and wrote to Prestwich to say that he ought to look into it. Prestwich accordingly made a pilgrimage to Abbeville, and came to the conclusion that there were in Boucher de Perthes' collection flints which had undoubtedly been wrought by man, which had been found in undisturbed ground, and which were of the same age as the remains of the extinct mammalia found with them.

Boucher de Perthes supported a good theory with much bad evidence, and we must bear in mind from all that passed then that there is need for caution in disbelief as well as in belief, and it may be that Prestwich's conviction may prove well-founded, that in the plateau gravels of Kent and Wiltshire there are flints worked by man of much earlier date than the palæolithic implements the genuineness of which he had with so much skill and pertinacity established. At present, however, the evidence as to these Palæotaliths or Eoliths, as they have been called, is not quite satisfactory, for natural forms have been exhibited with too much confidence as the work of man.

The view that there has been a great submergence of our island since glacial times will probably turn out to be correct, though it may be that the lapse of time over which it extended has not been rightly estimated. But the opinion that the phenomena could be best explained by submergence of such a transitory and tumultuous nature as to be properly called a flood will not at present command general acceptance. Prestwich himself seems to have been willing to qualify very considerably the statements involving the idea of a flood.

In endeavouring to interpret the story of the later accumulations it was, of course, most desirable to search for any local conditions which tended to preserve the relics which were chiefly relied upon as evidence, and such conditions appear to be furnished by the caves in which are found sealed up the remains of man who lived or buried his dead there, of the wild beasts which crawled in to die, or dragged in the bones of other dead animals to feed upon at their leisure.

Prestwich therefore paid much attention to the hyæna dens and other caves discovered from time to time round the coast or in inland cliffs. His object was to establish some chronology from the associated objects, or make out certainly any relation between the contents of the caves and of the raised beaches or river terraces which were by degrees beginning to be understood.

Prestwich was so impressed by the vastness of the changes which had taken place even during the latest geological ages that he began to doubt whether the operations of nature which we see going on around us were sufficient to bring about such great results, and he further saw evidence of more violent action in many of the phenomena of recent date. While not reviving the old cataclysmic views, he questioned the wide application of the uniformitarian doctrines as taught by Lyell; but their views will be easily reconciled, first, by the doctrine that local catastrophic action is quite consistent with continuity of causation; and, secondly, by the admission of the inevitable effects of ever-recurring earth movements in hurrying up or retarding the operations of denudation and deposition.

The theory that there exists an underground plateau of Palæozoic rocks extending at an inconsiderable depth beneath the Secondary and Tertiary rocks of East Anglia, interfering as at Ware with the water supply, and raising hopes everywhere of a new source of coal supply, which was partly suggested by De la Beche and put into shape by Godwin Austen, and which was verified at Harwich, Ware, London and Dover, was, of course, a subject of the greatest interest to Prestwich, and the progress of the investigation was largely advanced by him.

He was a pleasant letter writer, but as time went on he seems to have confined himself more and more to the object for which he had taken up his pen, and that was generally some scientific point. His sense of humour was strong, but showed itself more in conversation than in his letters.

At his pleasant home on the chalk hills he spent many happy days in later life, and there he breathed his last soon after Royal favour had recognised his long services by designating him as one of the recipients of the honours granted on New Year's Day 1896.

His memoir is written in a loving spirit, and there will be few amongst its readers who do not entertain towards him that affectionate feeling of regard and respect that would be very ill content with any other treatment.

## METEOROLOGY, OLD AND NEW.

*Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus.* Herausgegeben von Prof. Dr. G. Hellmann. Wetterprognosen und Wetterberichte des xv. und xvi. Jahrhunderts. (Berlin: Asher and Co., 1899.)

*Annals of the Astronomical Observatory of Harvard College.* Vol. xxxix. Pp. iv + 153. Part I. Peruvian Meteorology, 1888–1890. Compiled and prepared for publication by Solon I. Bailey, Assistant Professor of Astronomy, under the direction of Prof. E. C. Pickering. (Cambridge, U.S., 1899.)

*Annales de l'Observatoire national d'Athènes publiées.* Par Démétrius Éginitis, Directeur de l'Observatoire. Tome I. Pp. xxi + 395. (Athènes: Imprimerie Nationale, 1898.)

DR. HELLMANN has devoted himself with indefatigable application to the unearthing of those rare publications which illustrate the growth of an intelligent interest in the sciences of meteorology and magnetism, when these subjects first attracted attention

after the period of the Renaissance. Our columns have from time to time borne witness to his energy and to the merit of his selections. The present volume constitutes the twelfth of the series, and in matter of interest is not one whit behind any of its predecessors; while the beauty and fidelity of the facsimile reproductions will be acknowledged on all hands. In a short preface, Prof. Hellmann sketches the growth of the popularity of treatises on weather prediction, which circulated in great numbers before the close of the fifteenth century, whether in the form of almanacs or works of even greater pretension. The substitution of the language of the country for the learned Latin, which was in more general use prior to 1470, gave a great stimulus to the circulation, and on the continent of Europe these pamphlets and broadsheets won for themselves a warm welcome. Of the remains of this large harvest which have come down to us, Prof. Hellmann offers some typical selections, accurately reproduced as they circulated from hand to hand among various nationalities. Italy seems to have been earliest in the field to minister to the popular longing for this kind of literature, but later had to give way to German perseverance, which has won for itself the doubtful reputation of producing the greatest number of these almanacs. Prof. Hellmann has already given a catalogue of 600 distinct publications, but later study has made him acquainted with many more, and he now places the number at not less than 750. England and France, judged by the number of examples that have been preserved, do not seem to have exhibited anything like the same eagerness for the possession of this kind of writing which Germany, Italy, and the Netherlands exhibited. But specimens of all these various productions, graduated in point of time throughout the sixteenth century, are now made accessible to the student. England is represented by "An Almanacke and Prognostication" for 1555, by A. Aksham, priest and physician, which in the main outline differs but little from much earlier productions. An excellent example, dated 1506, due to the fancy of Leonardo de Richi, is presented in facsimile. As a rule it may be said that these various prophecies and indications begin with a dedication to some notability, then follow predictions relating to fruitfulness, conditions of health, wars and peace, in which is prefigured the fate of nobles and States, and towns and countries, and finally the times of moon changes are added, a knowledge of which is not only necessary for predicting the weather, but indicate the proper times for blood-letting and surgical operations. A modest section suffices for indicating the variations of the weather. We may quote an example from the Prognosticon of Julian de Blanchi which relates to October: "October ventosus et in eo aquae et tonitrua apparebunt, et dies dispositi ad aliquam aeris alterationem erunt iii., v., vii., xiii., xx., xxii., xxvi., xxxi."

The second volume quoted above refers mainly to an inquiry into the climate of Peru, but possesses a feature of distinct interest, to which we shall refer later. Peru has been roughly but conveniently divided into three regions, marked by the peculiarities of coast, mountain and forest climate. More particularly in two of these different localities, the enterprise of Prof. Pickering has established fully equipped meteorological observatories, and the present volume contains the discussion of the measures made at these stations between 1888-90. Mollendo, nearest the coast, is situated on the narrow strip of rock and sand which marks the abrupt rise of the continent from the waters of the Pacific. Chosica, further inland, is about twenty-five miles north-east of Lima. Here the climatic conditions fall midway between those of coast and mountain; for the land rises gradually from the ocean in successive ranges, each higher than that preceding it. The station itself stands on the summit of a conical mountain some 7000 feet high. Vincocaya and Puno, the two remaining stations in actual working order, are distinctly of the mountains. The former is near the crest of the Western Cordillera, on a desolate plateau nearly 15,000 feet in elevation. Puno is on the western shore of Lake Titicaca, and is typical of the great plateau which lies between the Western Cordillera and the Bolivian Andes. A few observations were also made at Pampa Central, near the central western part of the great desert of Atacama. Prof. Pickering describes this region as possibly the most barren on the earth. Not even a cactus breaks the monotony of the view near this town. The ground is rich in nitrates and other salts of immense commercial value; but the absence of rain on a soil of this character makes the region absolutely barren. In districts so uninviting and remote from the conveniences of civilisation, observers are found who, often without any hope of pecuniary reward, devote themselves to the maintenance of a continuous meteorological record. Self-registering apparatus is sometimes used, but the monotonous registration of the amount and character of cloud and similar data which go to decide the climate of a country, can only be secured by regular personal supervision; and though Prof. Pickering is obliged to reject some of the observations, owing to a suspicion of error, we think he is to be congratulated on securing an amount of co-operation which could hardly be anticipated in so inhospitable a country.

But the feature of special interest, and one that gives to the volume something of the charm that attaches to a work on travel, is the description of the establishment of two meteorological observatories near the summit of the lofty El Misti, a mountain which dominates the city of Arequipa, and from its symmetry, height and proximity constitutes the most imposing feature in the range of mountains that nearly encircles that town. It goes without saying that the approach to the summit is attended with great difficulties; but, rising as it does to a height of some 20,000 feet, or about 12,000 feet above the elevated plateau on which Arequipa stands, this truncated cone offers advantages to the meteorologist intent on studying the behaviour of the atmosphere at considerable elevations not less than the clear skies of Arequipa present to the practical astronomer. But only the most energetic would suggest to themselves the possibility of pursuing meteorological observations in a spot so inaccessible. Prof. Bailey gives us some account of earlier attempts, made at rare intervals, to reach the top of this venerated peak, some undertaken for the benefit of science, some from curiosity, but all, whether successful or not, accompanied with considerable danger and fatigue. Yet an observatory to be useful must be regularly and systematically visited. A tolerably

permanent mule track seemed to Prof. Bailey the best and only means of reducing the hardship of the ascent, and with true American ingenuity and enterprise he undertook the task of making a passable road up the sides of this barren mountain, over the remains of ancient lava streams and past huge slopes of volcanic sand, whose angle of ascent was oftentimes as much as 30°. Indians and Spaniards alike ridiculed the attempt, but Prof. Bailey persevered with his design, in spite of fatigue, mountain sickness, sulphurous vapours and the yielding character of the ground, into which the feet of the mules would sink six inches at each step. How he finally succeeded is modestly described in a chapter of great interest, to which we must refer for particulars. We can only record that at an altitude of 15,000 feet, approximately that of Mont Blanc, but in this latitude beneath the line of perpetual snow, the first observatory hut was set up, and, cheered by this success, it was resolved to attack the summit of the crater, and now eight feet above the highest point of the mountain a Robinson anemometer is successfully mounted, giving a continuous record of wind velocities in this elevated region. Other instruments from which records are obtained are a Richard self-registering hygrometer and thermograph, which register continually for ten days without interruption. Special thermometers and apparatus are mounted in a hut six feet square and seven feet high, on the very top of the mountain, a monument of well-directed vigour and indomitable resolution on the part of the director. We can but offer our congratulation on the completion of a work of so much difficulty, and hope that the results will equal in interest the labour by which they have been secured. Whatever may be the final outcome of mountain meteorology, Prof. Pickering has definiteiy secured, through the untiring efforts of Prof. Bailey, a chain of meteorological stations from Mollendo on the Pacific to the headwaters of the Amazon.

We have, unfortunately, but little space to do justice to the work of M. Éginitis. A thick volume filled mainly with meteorological observations and their discussion is apt to prove somewhat wearisome reading, but the director has managed to introduce some features of interest. In fact, the publication of the volume itself, indicating as it does the renewed activity of an observatory which has been practically non-existent since the death of Dr. J. F. Julius Schmidt, cannot but be welcome, and we may venture to hope that the observatory from which so much valuable work has emanated in the past will again be found among the institutions that contribute to the progress of science. M. Éginitis gives in an interesting chapter the history of the observatory since its erection, a record which in spite of sundry interruptions should prove inspiriting, since it demonstrates that the energy and ability of successive directors have risen superior to the difficulties inseparable from small instruments and straitened means. The volume is divided into two parts ; in the first the climate of Athens is discussed, the treatise being enlivened by the introduction of many extracts from the old classical authors. In the second part are given the readings of the various instruments, by the discussion of which the climate is determined.

W. E. P.

## *MACHINES FOR THE LIQUEFACTION OF GASES.*

*Liquid Air and the Liquefaction of Gases.* By T. O'Conor Sloane, Ph.D. Pp. 365. (London : Sampson Low, Marston, and Co., Ltd., 1899.)

THIS book may be regarded from three points of view : (1) as a popular account of recent work and experiments ; (2) as a scientific examination of the same ; and (3) as a historical summary and appreciation of invention in a special branch of science. As an instalment of popular science it has much interest. Readers who, guiltless of any exact science themselves, like to know what is going on in the modern scientific world, will find here a good deal that will help them to understand the significance of such steps in advance as are from time to time reported. As an exact critique of the progress of invention it is not a success. On p. 300, for instance, Dr. Sloane says : "The origin of the methods used by Tripler, Hampson and Linde can be studied in the records of the Patent Offices." Then referring to Mr. Tripler's patent of 1893, he says the apparatus therein described "is based on self-intensification for the production of cold. The Joule-Thomson effect is not appealed to in it." Shortly afterwards he says : "Linde and Hampson have both invoked" the Joule-Thomson effect "as the principle on which their machines operate." The teaching here, that, whereas the initial cooling in the Linde and Hampson machines is identical with the Joule-Thomson effect, it is in the Tripler machine produced in some other way, is entirely without justification and contrary both to good science and to common sense. The machines are all three based on the Joule-Thomson effect, and all three involve the use of self-intensification, while neither of these means is applied in Mr. Tripler's 1893 patent. More astonishing still, if Dr. Sloane is to be regarded as a scientific writer, are his approving references to this patent (its number, which he does not give, is 4210). This patent Dr. Sloane accepts as giving "a clear description with drawings" of a self-intensive refrigerator from which Mr. Tripler's present apparatus is derived. The apparatus is not a refrigerator at all, for it contains a fatal fallacy, the omission of cooling coils after the pump, to remove the heat of compression ; while the circuit is so arranged that for liquefying air no such coils could be introduced. The apparatus therefore, designed to produce cold, is a generator of heat. Secondly, even if it produced initial cooling, as expected, such cooling could never be intensified, since there is no self-intensive interchanger. An interchanger, to make the cooling effectively self-intensive, must have one end at the higher temperature, where the compressed air enters, the other end, where this air expands, at the extremely low temperature, and a continuous gradation of temperatures between them. In Mr. Tripler's patent there is no interchanger in which such an arrangement is possible. Again, on p. 295, Dr. Sloane praises Mr. Tripler's apparatus for its extreme simplicity, as using no refrigerant ; and after describing Dr. Linde's more complex laboratory system, with its preliminary refrigeration by ice and salt, he says, on p. 320, that the Hampson